DEPARTMENT OF ENERGY AIR-CONDITIONER/HEAT PUMP TEST PROCEDURE UPDATE

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ABSTRACT

The United States Department of Energy (DOE) test procedure that covers residential air conditioners and heat pumps is being revised in a two-step process. First, the test procedure is being updated, reorganized, and made more complete. However, the vast majority of the technical content is preserved, the use of U.S. customary (i.e., inch-pound) units is maintained, and modifications that would necessitate adjustments to the U.S. minimum efficiency standards are being avoided. The second step is to convert the test procedure to a metric format while maximizing compatibility with comparable standards of the International Organization for Standardization (ISO). Also, modifications passed over in prior revisions because they tended to shift the seasonal performance descriptors, SEER and HSPF, while not greatly impacting the relative rankings among units will receive greater consideration. If needed, adoption of the metric test procedure will be timed to coincide with a planned revision of the minimum efficiency standards.

In 1996, NIST revised the DOE test procedure and distributed it to several industry members for review. The numerous comments that were received have been summarized and a "NIST response" to each has been generated. Resolution of a few items is sought before the document is published as a proposed rulemaking.

Within this conference paper, several of the proposed changes to the DOE test procedure are mentioned while expanded discussion is offered on a few issues. Activities that impact the conversion to a metric test procedure, in particular an update on the development and revision of pertinent ISO standards, are described.

INTRODUCTION

Within the United States, the Department of Energy (DOE) manages the Energy Conservation Program for Consumer Products [1 - 7]. One component of this program is the development and maintenance of test procedures that specify standard methods for testing and rating "covered" appliances. Residential-size air conditioners and heat pumps are among these covered appliances. The National Institute of Standards and

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Technology (NIST) supports the DOE program by developing and maintaining the technical content of the test procedures. NIST assists DOE with the formal rulemaking process of generating a revised version, publishing it for comment, holding a public hearing, addressing all comments and making decisions regarding content, and publishing the final revision. In recent years, in addition, DOE has moved towards opening up the rulemaking process so that interested parties, referred to as stakeholders, are better informed and more involved throughout the revision process. Industry peer reviews, presentations, and discussions on potential test procedure modifications, especially at focused workshops, are examples of the mechanisms added for improving stakeholder participation.

The DOE test procedure of interest is formally titled "Uniform Test Method for Measuring the Energy Consumption of Central Air Conditioners." Although not done consistently, the phrase "Including Heat Pumps" is sometimes appended to this title. The test procedure, hereafter referred to in this paper as the DOE test procedure, is published annually as Appendix M to Subpart B of Part 430 within Title 10 of the Code of Federal Regulations [8]. With a few exceptions, air conditioners and heat pumps that are covered by this test procedure include air-to-air units that use single-phase power, have a rated cooling capacity less than 19 kW (65,000 Btu/h), and if housed in a single-package, are intended to connect to indoor ductwork.

The DOE test procedure is being revised in two steps. In 1996, NIST completed a proposed revision of the test procedure and distributed it to numerous industry members for review and comment. The main goal of this first-step revision is to update the test procedure. Sections were added to cover equipment types and equipment features that are not adequately addressed in the existing test procedure. Other general objectives of this first revision were to minimize "gray" areas and to improve the readability and organization of the document. For this first-step revision, the use of U.S. customary (i.e., inch-pound) units is being maintained and an effort is being made to avoid modifications that would require adjustments to the minimum seasonal performance levels specified by the U.S. energy conservation standards [9]. Such adjustments are required if the seasonal performance descriptors, SEER and HSPF, of minimally compliant air conditioners and heat pumps change as a result of modifications introduced within the DOE test procedure. SEER, which stands for Seasonal Energy Efficiency Ratio, reflects cooling season performance while the Heating Seasonal Performance Factor or HSPF covers, as the name implies, the heating season.

The second step revision of the DOE test procedure entails converting to Systeme Internationale (SI) units and to maximizing compatibility with pertinent standards of the International Organization for Standardization (ISO). Equipment covered by the DOE test procedure is covered by two separate ISO standards, one for ducted units [10] and one for non-ducted units [11]. An ISO working group is also working on a series of three standards that cover multi-split systems [12-14], which are distinguished by their ability to have one or more indoor coils active while one or more of the remaining indoor coils are inactive. Multi-split units are not explicitly covered in the existing DOE test procedure but are likely candidates for additions in the coming years. Like the DOE test procedure, the ISO standards evaluate steady-state performance. The ISO standards, however, do not include the extra steps required to estimate seasonal performance, as is required in the United States [15,16].

A few other changes to the DOE test procedure will be considered during the second step revision. Examples of changes under consideration include new defaults for the coefficients used to account for cyclic losses, new power and capacity adjustments for units tested without an indoor blower installed, and modifying the algorithm used to define the building load line. Because such changes, if adopted , are expected to impact

the seasonal performance descriptors, they would be best timed to occur when the SI conversion occurs so that the reworking of the test procedure occurs in one big step rather than in two or more smaller steps.

An update on the issues and status of each of the two revision steps are summarized in this paper. A few of the more interesting and substantive issues are described in more detail.

HISTORICAL PERSPECTIVE

Within the United States, a test procedure that first covered central air conditioners [17] and soon thereafter air-to-air heat pumps [18] was promulgated in the late 1970's , the latter becoming effective in January 1980. At that time, the test procedure covered single-speed and two-capacity split systems and single-packaged units, and implicitly addressed only ducted equipment. As it does today, the test procedure covered the method for calculating the seasonal performance descriptors, SEER and HSPF, based on the specified lab testing of the complete system.

The issue of which and how many units of a particular model line to test along with the requirements for estimating the SEER and HSPF of units that are not lab tested was addressed in conjunction with the earliest test procedure rulemakings. For split systems, each outdoor unit is tested with the indoor coil that is expected to be most often sold in combination with the outdoor unit. The ratings for the same outdoor unit when paired with other indoor units may be determined via the same testing protocol or may be estimated based on a DOE-approved alternative rating method. Alternative rating methods account for the relative impact from applying a different indoor coil design (e.g., fins per inch, face area, number of tube rows, etc.) and potentially introducing a different cooling mode expansion device and indoor fan. The measured performance of the tested combination, referred to as the matched system, provides the starting point for estimating the performance of untested, or mixed system, combinations. Submittal of lab results which provide limited verification of the alternative rating method and either participation in a voluntary certification program that conducts regular independent testing or certification of published ratings by an independent professional engineer are among the requirements for DOE approval.

Another area addressed early on was the issue of how to handle cases where the applicable DOE test procedure could not be used to test an appliance or where the test procedure did not equitably address an appliance's energy consuming characteristics [19-21]. In such cases, the approach taken is to grant the manufacturer a waiver from the applicable test procedure. The waiver may come in the form of simply not requiring that the unit to be tested and rated in accordance with all or part of the test procedure. More often, however, the approach taken is to introduce changes to the test procedure that would allow the unit to be tested and its seasonal performance estimated. A waiver applies only to the particular manufacturer and to a specified model line. The waiver typically remains in effect until the test procedure is revised to address the issues that originally necessitated the waiver. With regard to heat pumps and air conditioners, waivers have been requested, reviewed, and ultimately granted to address such issues as the use of a variable-speed components [22-26], no-defrost heat pumps [27,28], combined heat pump-water heating appliances [29,30], and burner-assisted heat pumps [31]. No-defrost heat pumps do not contain a defrost controller and instead seek to avoid frosting of the outdoor coil by restricting compressor operation to higher outdoor temperatures (e.g., above 4°C [40°F]); all heating at low outdoor temperature is provided via resistive heating. Combined appliances introduce an additional refrigerant-to-water condenser within the normal air conditioner or heat pump refrigerant circuit so that dual end uses can be met. Finally, burner-assisted heat pumps use

an electrically-powered compressor and a gas-fired burner in the outdoor coil. Depending upon the control strategy, the burner may be used to assure that outdoor coil never needs defrosting and/or is available for boosting heating capacity of the refrigerant condenser and allowing quick defrosts at lower outdoor temperatures.

In 1987, legislation was enacted that called for the setting of energy conservation standards for all DOE covered appliances [4]. These standards are commonly referred to as the minimum efficiency standards because they specify the minimum performance level(s) that an appliance must provide in order to be sold in the United States. For split systems, the energy conservation standards are an SEER of 10.0 and an HSPF of 6.8 and have been enforced since January 1992. For single packaged systems, the corresponding minimums are 9.7 and 6.6, respectively, and have been in effect since January 1993. The status on revising these standards, which are printed in the annually published Code of Federal Regulations [9], is discussed in a separate conference paper [32].

Since 1979, the DOE test procedure has been revised once, in March of 1988 [33]. Additions were made to expand coverage (and pre-empt waivers) to variable-speed air conditioners and heat pumps and to address split-type, non-ducted systems. The non-ducted systems that became covered in 1988 are those typically referred to as mini-splits. Such systems employ one or more wall-, ceiling-, or floor-mounted indoor coils, all of which cycle on and off together in response to the same indoor thermostat. One change that affected both the then-covered equipment and the newly-covered equipment was the algorithm for crediting units that provide a demand defrost capability. As a result of the change, the test procedure allows for an additional credit to HSPF for units that include smart controls that seek to defrost the outdoor coil only when needed. The HSPF credit, which depends on lab test results, can be as much as a 3 percent increase.

STEP ONE REVISION

June 1996 proposed revision

NIST completed work on a proposed revision of the DOE test procedure in June 1996 [34]. The document was distributed to several peer reviewers from industry, academia, and government. In addition to the proposed test procedure, the reviewers were provided a copy of the existing test procedure plus a summary of most of the proposed changes [35]. An abbreviated citing of the proposed changes is given in Appendix 1. Because the majority of the technical content of the test procedure was preserved and because the use of U.S. customary units is being maintained, the June 1996 proposed test procedure is not expected to impact the SEER and HSPF of air conditioners and heat pumps to the extent that would call for investigating adjustments to the energy conservation standards.

Revision of the DOE test procedure was initiated for the following reasons. The first reason was to address features presently found on commercially available units but not covered in the test procedure. Issues like how to test units having a time-adaptive defrost controller, how to conduct cyclic tests on units that ramp their compressor and fan speeds, and how to test units that incorporate a variable-speed, constant air volume rate indoor blower were addressed. A second reason for revision was to minimize "gray" areas. The best examples in this area are efforts to better define when the demand defrost credit is applicable and to limit lab installation practices that are inconsistent with how the majority of units are lab installed and are otherwise contrary to field practices. With regard to the lab installation, special sections within manufacturer

installation manuals that call for such things as washing the indoor and outdoor coils, disconnecting the power to the crankcase heater, and charging to a lower superheat would now be disallowed. The third reason for revision was to hopefully improve upon existing content. Examples include using a corrected equation for evaluating the volumetric flow of standard air, to limit adjustments used to account for barometric pressure effects, to reduce the testing burden associated with using the Outdoor Air Enthalpy Method, and to convert to a more robust curve fit for estimating the performance of a variable-speed unit when operating at an intermediate speed.

Figure 1 shows the differences from using a quadratic fit, as is now specified in the DOE test procedure, versus the proposed replacement, a linear over linear rational function. The rational function provides a fit which is very similar to a quadratic for the more likely case where the energy efficiency ratio (EER) and the coefficient of performance (COP) variation in the intermediate speed range is close to linear (see top two plots in Figure 1). In comparing the results for a variable-speed heat pump tested at NIST, the SEER and HSPF derived from using the two fits differed by 0.06 and 0.13 percent, respectively. The rational function, however, maintains a monotonic shape under all cases whereas the quadratic fit can provide an efficiency prediction that decreases and then increases (or vice versa) as compressor speed increases. Monotonic behavior is more representative. The lower plots of Figure 1 show how the two curve fits can differ.

As noted earlier, when the DOE test procedure is revised, an effort is to be made to incorporate changes that would do away with existing waivers. Since the last revision in 1988, the waivers that have been granted pertain to no-defrost heat pumps, combined heat pump-water heating appliances, and burner-assisted heat pumps. The June 1996 document, however, does not address any of these equipment categories. Instead, DOE and NIST plan to cover dual fuel appliances and combined space conditioning and water heating appliances in separate test procedures. In terms of the Code of Federal Regulations, the existing test procedure, Appendix M, would be limited to all-electric units that only provide space conditioning. In the future, new test procedures would be added to address combined appliances, Appendix M1, and potentially dual fuel heat pumps, including burner-assisted units, Appendix M2. By adding test procedures/appendices, Appendix M would not become unmanageably long. The expectation is to have Appendices M1 and M2 reference Appendix M as much as possible but otherwise contain those steps unique to testing and rating each of these new appliance categories. One contentious part with addressing both of these appliance categories is the method and what descriptors to use for rating purposes. Of these two, the plan is to come up with a proposed test procedure for combined appliances first, with publishing and review hopefully being completed by the end of 1998.

As for no-defrost heat pumps, NIST is awaiting input from both stakeholders and DOE. From a test procedure perspective, coverage of such units is relatively straight forward. At issue, however, is whether such units should be grouped with conventional heat pumps and, in particular, should they be subjected to meeting the same HSPF energy conservation standards. If the same HSPF standard is applied then the manufacture of such units will automatically become illegal because even the most efficient no-defrost heat pump cannot approach the NAECA minimum level of performance. Rationale for allowing the continued marketing of no-defrost heat pumps is that they are an energy saving alternative to an electric furnace and, when applied in a region having a very mild winter climate, yield an operating cost which is not substantially higher in absolute terms than the cost from operating a conventional heat pump.

In a related matter, NIST is also awaiting input on whether the DOE test procedure should address heat pumps that incorporate a heat comfort controller. Heat comfort controllers modulate the operation of the

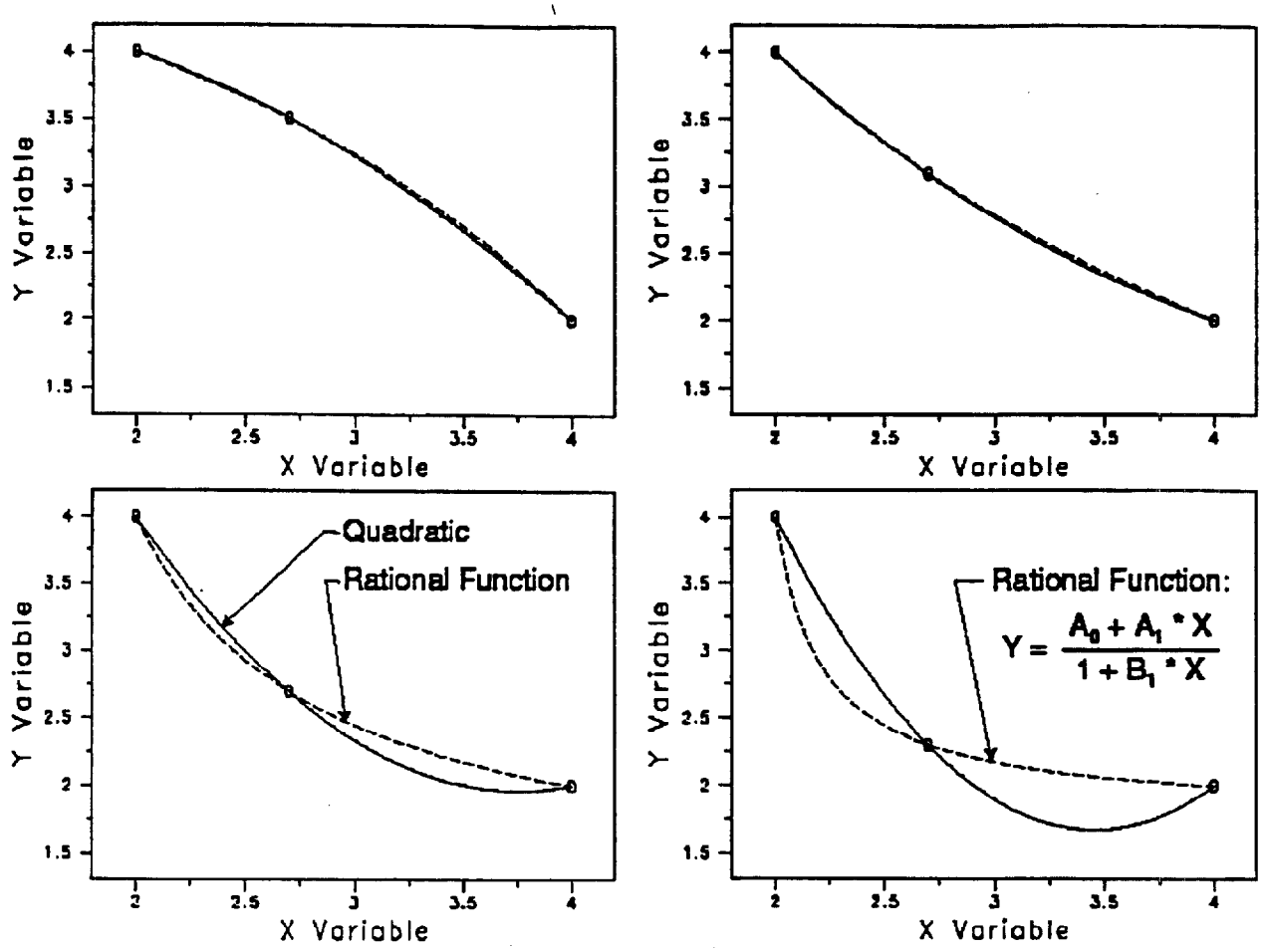

Figure 1. Comparison of fit options for the variable-speed heat pumps when operating at an intermediate speed: quadratic (solid lines) versus rational function (dashed lines)

heat pump's auxiliary resistive elements (i.e., strip heaters) in an effort to improve comfort and reduce peak electrical demand. In one configuration, the controller tries to modulate the resistive heating that occurs below the heat pump's balance point such that the delivery temperature does not swing from a lower value associated with only the heat pump running to a higher value achieved when the heat pump and all of the auxiliary strip heaters are heating. In the second configuration, the controller seeks to maintain a minimum air delivery temperature by using the resistive elements to temper the air leaving the refrigerant condenser coil. This minimum delivery temperature is adjustable, with a representative range being 27°C (80°F) to 43°C (110°F). Depending upon this minimum delivery temperature, the impact on seasonal efficiency can be zero or quite substantial [36].

Peer review findings

Of the numerous people to whom the June 1996 test procedure packaged was sent, several people provided written reviews and a few individuals shared their thoughts with NIST on specific items through in-person and phone conversations. NIST also gained input on test procedure issues by participating at meetings of the Standards Project Committee (SPC) working to revise Standard 37, "Methods of Testing for Rating

Unitary Air-Conditioning and Heat Pump Equipment," of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) [37]. Because it addresses how to test and calculate space conditioning capacity using a primary test method and via using a few secondary test methods, the majority of ASHRAE Standard 37 is referenced by the DOE test procedure.

As a result of the reviews and participation at ASHRAE SPC 37 meetings, a few substantive issues and several lesser issues have been identified. Probably the biggest general issue is to define what equipment types should be covered by the DOE test procedure. In addition to no-defrost heat pumps and heat pumps with heat comfort controllers, NIST is seeking feedback from manufacturers as to the need to cover:

1. Triple capacity heat pumps
2. Multiple split heat pumps
3. Single speed heat pump with variable-speed indoor fans that are modulated based on:
    A. outdoor dry bulb temperature
    B. best matching the building load
4. Two-capacity heat pumps with variable speed indoor fans that are modulated to best match the building load.
5. Two-capacity heat pumps where the unit is sized to meet the space cooling load at design conditions – the test procedure uses 35°C – while operating at low capacity
6. Two-capacity heat pumps that lock out low capacity operation at outdoor temperatures where frost may accumulate on the outdoor coil
7. Multiple capacity air conditioners and heat pumps having a "turbo"cooling mode
8. Others?

Comments were received which addressed ways for improving the proposed method for testing units having a variable-speed, constant air volume rate indoor fan and for scrapping the proposed approach in favor of an alternative method. Varying views were expressed on the proposed criteria for allowing the demand defrost credit. The main finding here was that in an effort to curtail allowance of the credit to units that truly do not offer a demand defrost capability, NIST had erred in making the criteria too restrictive. As for the section added to disallow unrepresentative lab installation instructions, the three received comments supported its deletion. One commenter stated that the industry's independent certification program adequately polices such matters. Another commenter expressed concerns that such parameters as indoor and outdoor air flow rates and fan time delays could potentially be incorrectly set due to the introduction of the new section. At this time, NIST does not believe that the second commenters concerns will be realized and questions if the industry certification program seeks to avoid unrepresentative equipment installations then why can't the DOE test procedure do the same?

The written comments from the peer review have been organized and grouped. A NIST response to each individual or group of like comments has been generated and supplied to DOE [38]. In an effort to address issues where differing viewpoints were received, a one-day workshop is scheduled for September 25, 1997 at DOE headquarters, Washington D.C. In addition to the issues noted above, discussion is planned on the impact of barometric pressure and how it should be handled, the need for an outdoor wet bulb temperature test condition when testing packaged units that have the indoor coil in the outdoor chamber, and proposed changes and clarifications on instrumentation requirements.

Following the DOE workshop in September, NIST will revise the proposed test procedure and submit it for DOE internal review. A separate report will be composed that summarizes the input gained as a result of the

workshop along with pertinent information and comments obtained prior to the workshop. This separate report will be used as a starting point for writing the preamble that will accompany the revised test procedure when it is published in the Federal Register as a proposed rulemaking.

STEP TWO REVISION

Once the DOE test procedure is brought up-to-date, the next step will be to generate a proposed revision that uses SI (or metric) units and references international standards. The conversion to SI units affects the test conditions, test and equipment tolerances, and the bin temperatures, building loads, and fractional bin hours used for calculating SEER (of two-capacity and variable-speed units) and HSPF. With regard to international standards, NIST is hopeful of harmonizing the DOE test procedure with ISO Standards 15253 and 5151, which address requirements for determining the rated cooling and heating capacities of ducted and non-ducted systems, respectively.[1] By default, the ISO Standards address a subset of the metric conversion issues, like test conditions and test tolerances. Of course, the ISO Standards also address non-metric issue like the test methods to be used. The similarities and differences between the DOE test procedure and ISO Standards are introduced below. At this time, the extent of the eventual harmonization remains uncertain.

With regard to cooling capacity ratings, the ISO Standards specify test conditions for three different climates: cool, moderate, and hot. The manufacturer may choose to have a unit rated for one, two, or all three climates. The indoor and outdoor test conditions associated with each climate rating are listed in Table 1. The moderate climate indoor test conditions are close to the indoor dry bulb/wet bulb temperatures presently used for all DOE, wet coil, cooling mode tests: 26.7°C/19.4°C (80/67°F) . The ISO moderate climate outdoor dry bulb temperature is an exact match of the value specified for the DOE A-Test. Although not covered in ISO Standards 13253 and 5151, part-load testing is addressed in two ISO Proposed Working Drafts for multi-split systems (15042-2 and 15042-3). The moderate climate part load test conditions that are presently cited in these two drafts are comparable to the values specified for the DOE B-Test. The difference in indoor conditions is the same as noted above between the DOE wet coil tests and the ISO Table 1 values. The ISO part-load test outdoor dry bulb temperature is 27°C versus the DOE B-Test value of 27.8°C (82°F).

The ISO Standards call for three heating capacity ratings tests. The three tests apply for all climates although the "extra-low" temperature test is waived if the heat pump does not operate at the specified outdoor temperature. The outdoor side test conditions for the three heating capacity ratings tests plus the indoor side conditions used for all three tests are given in Table 2. Again the ISO and DOE test conditions are very similar with the latter calling for a 21.1°C (70°F) indoor dry bulb temperature and comparable outdoor dry bulb/wet bulb temperatures of 8.3/6.1°C (47/43°F), 1.7/0.6°C (35/33°F), and -8.3/-9.4°C (17/15°F).

The DOE test procedure and the ISO "ducted" standard (13253) require that the Indoor Air Enthalpy Method shall be used for providing the primary measurement of capacity. The ISO "nonducted" standard

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[1]Although not pertinent to the DOE test procedure and therefore not discussed further here, the ISO Standards also address pass-fail type performance tests in the same manner as Standard 210/240-94 of the Air-Conditioning and Refrigeration Institute (ARI) [39].

Table 1. ISO Cooling Capacity Test Conditions			
	Standard Test Conditions for Each Climate		
	Cool	Moderate	Hot
Temperature of air entering indoor side, °C (°F)			
dry bulb	21 (69.8)	27 (80.6)	29 (84.2)
wet bulb	15 (59.0)	19 (66.2)	19 (66.2)
Temperature of air entering outdoor side, °C (°F)			
dry bulb	27 (80.6)	35 (95.0)	46 (114.8)

Table 2. ISO Heating Capacity Test Conditions			
	Standard Test Conditions		
	High	Low	Extra Low
Temperature of air entering the indoor side, °C (°F)			
dry bulb		20 (68.0)	
wet bulb (maximum)		15 (59.0)	
Temperature of air entering the outdoor side, °C (°F)			
dry bulb	7 (44.6)	2 (35.6)	-7 (19.4)
wet bulb	6 (42.8)	1 (33.8)	-8 (17.6)

(5151) states that either the Indoor Air Enthalpy Method or the Room Calorimeter Method (indoor side) shall be used. When the Room Calorimeter Method is used on the indoor side, a simultaneously conducted confirming test which agrees within 4 percent is required. For the ISO standards, a confirming test is optional if the Indoor Air Enthalpy Method is used. The DOE test procedure, by comparison, requires a confirming test for all steady-state tests with the resulting capacity measurement agreeing within 6 percent of the value obtained using the Indoor Air Enthalpy Method. With the exception of the option of using the Room Calorimeter Method on the outdoor side, the test methods that may be used to provide the confirming measurement of capacity are the same for both the DOE test procedure and the ISO standards. The majority of other differences that exist between the ISO heat pump standards and the DOE test procedure are listed in Table 3.

At their April 1997 meeting, the ISO subcommittee that is responsible for the ISO Standards 13253 and 5151 voted to reconvene a reconstituted working group to consider revisions to these standards. The first meeting of the working group is scheduled for September 10-12, 1997 in Lyon, France. ARI and NIST have worked together to generate a list of proposed revisions which will be among the agenda items discussed at the September meeting.

Table 3. Compatibility Differences: ISO Standards 13253 and 5151 Versus the DOE Test Procedure		
Subject	ISO Standards	DOE Test Procedure
Test Voltages	At the rated voltage; if dual rated, required to test at the lower voltage with tests at the higher voltage being optional	Test at 230 V
Test Procedure for Frosting Tests	3 Hour Test; average heating capacity based on number of completed cycles; average power based on the full 3 hours	Complete cycle test: one frosting interval and one defrost interval; capacity and power based on the complete frost/defrost cycle
Decision on Whether to Conduct a Steady-state or Frosting (Transient) Test	Decision based on whether 30 minutes of data can be obtained before the air leaving the indoor and/or outdoor coil exceeds specified limits.	Tied to the test conditions. The frosting test is used for tests conducted at outdoor conditions of 1.7/0.6°C (35/33°F). All others heating tests are steady-state tests.
Test Operating Tolerances	Maximum ± variations from rating conditions	Maximum range that a parameter shall vary (absolute values that are not tied to rating conditions)
Instrumentation Specifications	Required measurement uncertainties are specified in the main text; optional tighter instrument accuracies are specified in an informative annex.	The DOE test procedure specifies required instrument accuracies that are consistent with the tighter values that appear in the noted ISO informative annex
Air Flow Requirements: Ducted and Non-Ducted Units	No limits on the maximum air volume rate	Maximum indoor air volume rate limited to 0.060 m^3/s of standard air per 1000 watts of rated capacity (37.5 scfm per 1000 Btu/h)
Air Flow Requirements: Ducted Units	1. External static used for testing specified by manufacturer. 2. Capacity adjusted if the fan heat is greater that the declared measurement uncertainty. 3. Power and, if applicable, cooling capacity adjustments are estimates assuming the fan provided a zero external static pressure.	1. External static specified in the test procedure 2&3. For united tested with an indoor blower, the capacity and power measurements reflect the fan's heat and power contributions. For units tested without an indoor blower, default power and capacity adjustments are applied.

While participating in the effort to revise ISO Standards 13253 and 5151, NIST will also be working on the remaining issues associated with conversion to metric DOE test procedure. Comparable test conditions to those now specified for multi-capacity units when operating at low capacity or minimum speed, or at an intermediate speed will be selected. Also, different ways for converting the SEER and HSPF calculation algorithms to a metric format will be tried. The potential for other changes that are unrelated to the metric conversion and the pursuit of ISO compatibility will also be explored. For example, the possibility of assigning new defaults in lieu of determining the cooling and heating mode degradation coefficients, C_D, via testing (i.e., by conducting two extra cooling mode, dry coil tests - one steady-state and one cyclic - and one extra heating mode cyclic test) is planned. To aid this effort, ARI has indicated a willingness to share historical C_D data with NIST. NIST will attempt to identify representative C_D values that correlate with system hardware descriptions. The expectation is that rather than have the presently-allowed one C_D default for both cooling and heating, the DOE test procedure will contain multiple, more representative C_D defaults for each mode.

Once a better picture exists as to the content of the revised ISO Standards, 13253 and 5151, and NIST has completed the other investigations discussed as part of the step two revision, a draft proposal of a metric DOE test procedure will be generated and, most likely, released for peer review. At or prior to that time, NIST will seek to have lab testing conducted to better quantify the impact from changing to the new test procedure. If the impact is minor such that the new metric SEERs and HSPFs are consistent with the values obtain using the inch-pound version of the test procedure (e.g., differ by a scaling constant or share a similar offset), then the test procedure will be introduced as soon as possible. Otherwise, the metric test procedure will probably become effective some time well after its content is finalized so that manufacturers have additional time to prepare for the conversion. Timing the effective date to coincide with the enactment of revised minimum efficiency standards would be pursued as well.

SUMMARY

Work to revise the DOE test procedure for air conditioners and heat pumps in two steps is underway. The first step revision is being conducted to bring the test procedure up-to-date while maintaining the use of U.S. customary units. The proposed revision has completed an industry peer review. In an effort to reach consensus on as many issues as possible, a workshop will be held on September 25,1997 in Washington D.C. Based on feedback gained as a result of this workshop, the proposed test procedure will be revised and then submitted for DOE internal review. Publishing the revised test procedure as part of a proposed DOE rulemaking in the Federal Register will follow.

In the second step revision, the DOE test procedure will be converted to using SI units and will reference ISO Standards 13253 and 5151. The extent that the DOE test procedure references these ISO Standards, however, will depend on the ISO working group that was recently reconvened to consider modification to Standards 13253 and 5151. Presently, several differences exist between the DOE test procedure and the ISO Standards. The first meeting of the working group is scheduled for September 10-12, 1997.

REFERENCES

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[2] Department of Energy Organization Act (DOE Act), Section 301, Public Law 95-91.

[3] National Energy Policy Conservation Act (NEPCA), Public Law 95-619, 92 Stat. 3266.

[4] National Appliance Energy Conservation Act of 1987 (NAECA), Public Law 100-12, Enacted March 17, 1987.

[5] National Appliance Energy Conservation Amendments of 1988, Public Law 100-357.

[6] Energy Policy Act of 1992 (EPAct), Public Law 102-486.

[7] Code of Federal Regulations, Title 10 (Department of Energy), Part 430, U.S. Government Printing Office, Washington, D.C., 1997.

[8] Code of Federal Regulations, Title 10 (Department of Energy), Part 430, Subpart B, Appendix M, "Uniform Test Method for Measuring the Energy Consumption of Central Air Conditioners," U.S. Government Printing Office, Washington D.C., 1997.

[9] Code of Federal Regulations, Title 10 (Department of Energy), Part 430, Subpart C, 430.32(c), U.S. Government Printing Office, Washington, D.C., 1997.

[10] International Organization for Standardization, "ISO Standard 13253, Ducted Air-Conditioners and Air-to-Air Heat Pumps – Testing and Rating for Performance," Geneva, Switzerland, November, 1995.

[11] International Organization for Standardization, "ISO Standard 5151, Non-Ducted Air-Conditioners and Heat Pumps – Testing and Rating for Performance," Geneva, Switzerland, December, 1994.

[12] International Organization for Standardization, "ISO Committee Draft 15042-1, Multi-Split System Air-Conditioners and Air-to-Air Heat Pumps – Testing and Rating for Performance – Part 1: Basic and Multiple Circuit Systems," Geneva, Switzerland, June 18, 1997.

[13] International Organization for Standardization, "ISO Proposed Working Draft 15042-2, Multi-Split System Air-Conditioners and Air-to-Air Heat Pumps – Testing and Rating for Performance – Part 2: Modular Multi-Split Systems," Geneva, Switzerland, March 8, 1997.

[14] International Organization for Standardization, "ISO Proposed Working Draft 15042-3, Multi-Split System Air-Conditioners and Air-to-Air Heat Pumps – Testing and Rating for Performance – Part 3: Modular Heat Recovery Multi-Split Systems," Geneva, Switzerland, March 10, 1997.

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[17] Federal Register, "Final Rulemaking for Test Procedures for Central Air Conditioners," Vol. 42, No. 227, p. 60150, U.S. Government Printing Office, Washington, D.C., November 25, 1977.

[18] Federal Register, "Final Rulemaking for Test Procedures for Central Air Conditioners, Including Heat Pumps," Vol. 44, No. 249, p. 76700, U.S. Government Printing Office, Washington, D.C., December 27, 1979.

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[25] Federal Register, "Decision and Order Granting Waiver From Test Procedures for Central Air Conditioners, Including Heat Pumps, to the Trane Co. And Modification of a Decision and Order Granting Waiver From Central Air Conditioner and Heat Pump Test Procedures to Carrier Corp. (Case Nos. CAC-002 and CAC-001)," Vol. 52, No. 70, p. 11855, U.S. Government Printing Office, Washington D.C., April 13, 1987.

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[28] Federal Register, "Decision and Order Granting Waivers From Central Air Conditioner Test Procedure to Airlex (Case No. CAC-004)," Vol. 53, p. 52216, U.S. Government Printing Office, Washington D.C., December 27, 1988.

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[34] Dougherty, B.P., "Proposed Revision – June 1996: Appendix M to Subpart B – Uniform Test Method for Measuring the energy Consumption of Central Air Conditioners," Letter Report Prepared for the Department of Energy, National Institute of Standards and Technology, Gaithersburg, MD, June 1996.

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APPENDIX 1. JUNE 1996 PROPOSED CHANGES TO THE DOE TEST PROCEDURE

	Proposed Revision	Description
1	Update and add references for industry standards	Existing test procedure references standards from 1976, 77, 78, and 79; propose citing five additional standards
2	Protocol for testing units having a variable-speed, constant CFM indoor blower	Measure the external static pressure during the first test; for all other tests where the unit seeks to operate at the same CFM, attempt to achieve the same external static pressure
3	Air volume rates	Allowing air volume rate (standard air) for cooling and heating tests to be different; corrected equation for calculating volume rates of standard air; address air volume rates for all tests on two-capacity and variable-speed units.
4	Cyclic testing - general	Adopted test protocol information from ASHRAE Standard 116-95 and ARI Standard 210/240-94. Revise protocol used for split-type, non-ducted units
5	Cyclic testing - units that ramp their fan speed when cycling	Previously not addressed; propose maintaining requirement of step response in air flow because testing is easier and impact is expected to be minor
6	Test tolerances	Deleted, added, and modified a select few tolerances and tried to more clearly state when a particular tolerance applies
7	Pre-test interval	Introduce the same requirements for like tests; more specific with regard to the steps during cyclic, frost accumulation, and low temperature tests
8	Multi-capacity systems	Switched to using a rational function (linear/linear) for fitting EER and COP data when operating at an intermediate compressor speed; added coverage for units that lock out low capacity operation at lower outdoor temperatures
9	Unit with a single-speed compressor and a variable-speed indoor fan that modulates based on outdoor temperature	Added sections to address the testing requirements and SEER and HSPF calculations
10	Defrost Adjustment Factor	For heat pumps, attempted to clarify the criteria under which the maximum 3 percent HSPF increase for demand defrost capability may be applied

11	Units that use a time-adaptive defrost control strategy	Relaxed the requirement that the primary defrost cycle during a Frost Accumulation Test must be induced automatically; to allow repeatability, the primary defrost on time-adaptive units shall be manually imposed after a time interval specified by the manufacturer
	Proposed Revision	Description
12	Efforts to assure that the lab installations are comparable and, as much as possible, consistent with field practices	Manufacturer's installation instruction sometimes include special requirements that are specified only for lab tests and which are inconsistent with both a field installation and the installation practices of the majority of units that are lab tested; examples include requirement for washing indoor and outdoor coils prior to testing, disconnecting the power supplied to the crankcase heater, and charging the unit to a lower superheat.
13	Test apparatus and measurement specifications	Clarified setup with regard to inlet plenum and temperature grid requirements; introduced recommended manifolded static pressure tap configuration and tighter voltmeter accuracy; added duct loss correction and formalized the option of using dew point hygrometers
14	Different compressor capacities and indoor fan speeds between cooling and heating tests	Expanding on what is presently allowed for variable-speed systems by allowing different air volume rate to be used for cooling tests versus heating tests; this change is more representative of actual operating practice and is especially needed because of the difficulty in forcing variable-speed, constant CFM blowers to run at the same SCFM under both cooling and heating inlet conditions; also allowing the option of testing a two-capacity unit sized to meet the design cooling load while operating at low capacity
15	Barometric pressure effects	Existing test procedure references the ASHRAE Standard 37 capacity adjustment for deviations from standard pressure; these existing adjustments are being re-evaluated
16	Reduce testing burden of secondary test method requirement	Trying to limit the number of preliminary tests conducted when using the Outdoor Air Enthalpy Method to provide the secondary measurement of capacity; for units that operate the outdoor fan at a fixed speed for multiple, like mode tests, the preliminary test shall be waived
17	Miscellaneous	Fan heat and power adjustments expressed in terms of volume rates of standard air; adopted ARI Standard 210/240-94 enclosure specification when testing nonpackaged coils; specifying outdoor wet bulb instead of dew point for Frost Accumulation Test; eliminating references to heating-only heat pumps